FOREIGN HONORARY MEMBERS.

THE MARQUIS OF CALIGNY.

AN ancient family, which since 1660 had produced a succession of military engineers, became extinct by the death of the Marquis of Caligny; several of its members were esteemed by Vauban, and their works are yet well known to civil and military engineers.

ANATOLE FRANÇOIS HÜE, MARQUIS DE CALIGNY, was born at Valognes (Manche), May 31, 1811. The son of Bernard-Henri-Louis Hüe, Marquis de Caligny, and Eugénie-Marie-Léonore-Avice de Fermanville. He was related to many of the illustrious families of France, and popular tradition affirmed that his descent could be traced from Charlemagne; however this may be, it is certain that he was the last of a distinguished group of hydraulic engineers, among whom may be mentioned Louis Roland de Caligny, founder of the port of Cherbourg.

De Caligny entered the College of St. Lô in 1822, where he first met Leverrier, who became his intimate friend. This friendship, based on a similarity of tastes, remained constant and unalterable, in spite of the great astronomer's changes of opinion. Caligny remained firmly Legitimist and Catholic, for him the political changes subsequent to 1789 were as if they did not exist; with this difference, the two were as brothers.

At the age of sixteen, he began the study of philosophy at Valognes, in order to be near his family, who resided in the Château de Flottemanville, a league from that town. The next year he took up his residence at the Château, where he conceived the first ideas of his inventions.

Following the advice of the Cherbourg engineers, he removed to Paris in 1836. Here he recommenced his experimental investigations, which were to be pursued with little interruption for half a century.

He soon made the acquaintance of Coriolis, who, appreciating his researches, advised him to embody them in a report to the Institute. In conformity with this suggestion, he prepared a memoir on "Hydraulic Machines with Oscillating Liquid Columns," which was presented to the Academy and referred to a committee consisting of MM. Poncelet,* Coriolis, Gambey, and Seguier, who reported so

* Poncelet was his predecessor in the American Academy.

favorably upon it, that the Academy awarded him the Montyon Prize * in Mechanics, which had just been established. Caligny's invention is thus described in the report of the committee: "The happy idea which distinguishes this machine, and characterizes it as a veritable invention, is the discharge through a vertical tube, after an upward oscillation, without the loss of any living force except that consumed by friction; that is to say, by depressing very slightly the centre of gravity of the fluid column to be discharged. Without doubt the machine appears simple both in conception and construction, but this simplicity only enhances its merits."

From this time Caligny's success was assured. He was the discoverer of a new branch of hydraulics, namely, that relating to oscillating liquids; and he published from time to time accounts of his researches, which were remarkable both for the methods employed and the results obtained. To these researches he devoted his life, never attaching himself to any administration, nor taking part in any private enterprise; he even refused to take patents for his inventions, preferring to devote himself with indefatigable zeal to the disinterested pursuit of science.

On several occasions his rights of priority were disputed, but they were always easily established by means of his publications in the transactions of the French Academy. His investigations were brought together in 1883, in two volumes entitled, "Theoretical and Experimental Researches on the Oscillations of Water and Hydraulic Machines with Liquid Oscillating Columns." Prizes were awarded to his machines at all the International Exhibitions, and he received numerous diplomas from different European Academies.

The following succinct account of his first apparatus is thus given by M. Boussinesq: —

"From the bottom of a reservoir containing water at rest, a long horizontal or slightly inclined conduit issues, having its further end terminated by a vertical pipe of the same diameter as the conduit, and rising some distance above the level of the reservoir. It is proposed to raise and discharge the water from the top of this pipe. For this purpose, a valve movable around a horizontal axis, manipulated from without, separates the empty vertical pipe from the conduit filled with water under pressure. The valve, being at a given moment released, is raised by the water which begins to rise in the pipe, and that in the conduit also, but only little by little, on account of its great mass.

* This prize consists of a gold medal valued at 500 francs.

Its living force attains its maximum at the instant when the liquid in the pipe rises to the reservoir level. This living force is capable, except for the slight loss due to friction, of carrying the ascending liquid column as high above the reservoir level as its point of departure was below it. As only a part of the force has been consumed at the moment when the liquid begins to pour out above, the discharge continues until the whole column in motion has been brought to rest. But at this moment the valve falls by its own weight, and opens at the same time a short horizontal tube which it closed while it was raised, thus offering a free exit for all the water in the vertical pipe, which thus rapidly escapes into a second reservoir just above the level of the valve. The liquid contained in the horizontal conduit during this time comes to rest, and then begins to oscillate by raising the valve; then a new period of ascension with discharge begins."

If Caligny's experiments had not been realized for half a century, might not this description have been taken as a project for perpetual motion?

In 1868, the Administration of Roads and Bridges built, on a working scale, Caligny's new system of saving basins for canal locks, at the Aubois Lock, upon the lateral canal of the Loire.

Here he made many experiments with the help of the Administration. Inspector General Vallés accompanied him, made a report to the Institute, and published a memoir entitled, "Experiments made at the Aubois Lock to determine the useful Effect of the Apparatus by the aid of which M. de Caligny greatly diminishes the Consumption of Water in Navigable Canals."

The following description of this apparatus is taken from the United States Report* on the Vienna International Exhibition.

Description of the Aubois Canal Lock.

Process invented by the Marquis of Caligny. — We know that for each passage through a lock, whether up or down, a quantity of water must be drawn from the upper bay to fill up the lock to a height equal to the difference of level between the two bays, this height being called the lift of the lock, and the volume of water required for this purpose the prism of lift. The system invented by the Marquis of Caligny and applied to the Aubois lock has for its object to diminish this waste by causing water from the lower bay to ascend into the lock-chamber when the latter

* Civil Engineering, Public Works, and Architecture. By William Watson, U. S. Commissioner.

is to be filled; and also by making part of the water in the lock-chamber ascend to the fore-bay when the lock-chamber is to be emptied. The system is founded on the known properties of oscillating liquids.

The work consists (omitting the details): —

First. Of an aqueduct connecting the lower gate-chamber with two separate reservoirs, U (upper) and L (lower), situated behind the upper gate-chamber.

Second. Of a discharging-channel or saving-basin, connecting the reservoir L with the lower bay by a sluice; the other reservoir, U, communicates with the upper bay.

Third. Of two vertical movable pipes, u, l, open at both ends, and resting upon two circular openings made in the walls of the aqueduct. One of these pipes, u, is placed in the reservoir communicating with the upper bay, and the other, l, in the one communicating with the lower bay. When these pipes are lowered upon their seats, the upper extremity of the aqueduct is shut. If we raise the upper pipe, u, the water from the upper bay enters the aqueduct; if, on the contrary, we raise the lower pipe, l, the water from the lock goes into the saving-basin, or *vice versa*, according to their respective levels.

The manner of working is as follows. Suppose the full lock is to be emptied; we raise the pipe l, the water from the lock-chamber passes through the acqueduct under the pipe, and enters the saving-basin, which is supposed to be on a level with the lower bay. After having held the pipe l raised during a few seconds for the water to acquire its velocity, we drop it back upon its seat; the water in the aqueduct, having no issue under the pipe l, rises in the interior of both l and u, and pours over their tops into the reservoir U, connected with the upper bay. Thus, on account of the living force of the moving liquid mass in the aqueduct, a part of the water is carried into the upper bay. When this first oscillation has ceased to cause the water to overflow from the pipes u and l, we recommence the same operation by raising again the pipe l; a new column of water issues from the lock; we interrupt again its flow under l, and a new oscillation produces a new overflow into the upper bay. As this operation is repeated the lock is emptied, one portion into the saving-basin and thence into the lower bay, another portion into the upper bay.

Without entering further into the details of the operation, the results may be stated as follows.

This canal lock has been in operation since 1868, and we find: —

First. That seven or eight oscillations suffice to fill or empty the lock in five or six minutes.

Second. That for filling the lock without using the reserve in the saving-basin the volume of water taken from the lower bay is 0.41 V, V being the prism of lift, so that the saving by this operation is about two fifths of V.

Third. That during the process of emptying the volume sent into the

upper bay is about 0.386 V, without considering what is saved by the final oscillation. The sum of the volumes raised by the two operations is $(0.41 + 0.386)\ V = 0.796\ V$. By utilizing the great final oscillations the saving amounts to 0.90 V.

This system, while it economizes the water used, produces neither lowering in short bays, nor exaggerated velocities in the narrow passages, and constitutes an ingenious use of the properties of liquids in motion. Its application to the Aubois lock cost about 40,000 francs, but much of this was owing to the difficulties of position and the nature of the soil, which required special precautions. A considerable economy might be made by placing the aqueduct along the side walls of the lock.

AWARD. — The jury for Group XVIII. awarded to the Marquis of Caligny the Medal for Progress.

At this time, M. de Caligny was elected Corresponding Member of the Institute of France. On the death of Clausius, Caligny became Dean of the Corresponding Members of the Institute; and at this time he was elected into the American Academy to fill the vacancy thus made.

On the occasion of the Universal Exhibition at Paris in 1889, a considerable space in the Department of Agriculture was allotted for the display of a number of Caligny's ingenious contrivances for raising water, and the author of this notice had the pleasure of seeing these machines in operation, and of observing how thoroughly they were adapted to the requirements of agricultural irrigation.

M. de Caligny rendered a service to history and to military art by publishing six octavo volumes of the Military Memoirs of Marshal Vauban and the engineer Hüe de Caligny, his ancestor, extracted from his personal archives. This work was published in Paris in 1841. It will be remembered that his three elder brothers died for their country; one killed in 1807 at the battle of Eylau, the others in 1813 at Lutzen. During a visit to Versailles in 1878, Caligny showed the author a list of his military ancestors, among whom were several who served in America under Rochambeau.

Toward the end of his life his sight became impaired, but this affliction was tempered by the care and assistance of his courageous wife, who served him as secretary.

His death occurred on the 24th of March, 1892, in the eighty-first year of his age. The local journal, "Le Petit Versailles," says of him, "C'était un homme de bien, dans toute l'acception du mot." To this just appreciation, Catalan, his intimate friend for more than half a century, adds, "Il était simple et bon." The words in-

scribed upon Gay's monument might, with equal truthfulness, be Caligny's epitaph: —

> "Of manners gentle, of affections mild;
> In wit, a man; simplicity, a child."

PAPERS PUBLISHED. — MEDALS AND DIPLOMAS RECEIVED.

1837. New Principles on the Oscillations of Water, and New Hydraulic Machines.

This was made part of the instruction given at the Polytechnic School at Paris.

1838. New System of Canal Locks; and a New Apparatus to raise Water without any movable Valve.

1839. On a New Hydraulic Motor with Oscillating Floats.

This year he joined the Paris Philomathic Society.

1840. A Report to the Institute on an Hydraulic Motor of his invention.

Intermittent and Oscillating Fountains.

Experiments on the Oscillations of Water in a large Conduit in Paris.

1841. Intermittent Fountains under the Sea.

1843. Experiments on the Motions of Waves.

Experiments on a large scale with an Hydraulic Motor with Oscillating Floats.

1844. Experiments on Conical diverging Mouthpieces, and on several kinds of Liquid Waves.

On a New Blowing Engine, or Air Compressor; for which he received a Gold Medal from the King of Sardinia.

1845. On Breast Wheels.

Historical Researches on Hydraulics.

Elected Corresponding Member of the Royal Academy of Sciences at Turin.

1846. Studies in Hydraulics. Second System of Compressors.

1847. Experiments on a Model of a Canal Lock and on Two Hydraulic Motors with Valvular Pistons. On Vertical Wheels, with Curved Floats, and fed from within.

1848. Observations on Water Vortices.

1849. Description of a New Hydraulic Machine.

1850. Experiments on Mouthpieces, Curbs, Vortices, Waves, and the Friction of Water.

Experiments on a new Machine founded on a Phenomenon of Suction just discovered.

Elected Correspondent of the Royal Society of Sciences at Liége.

1852. New Draining Machine operated by Means of Sea Waves.

Observations on the Waves at Fécamp, France.

Gold Medal from the Central Society of Agriculture.

Experiments on several pieces of Apparatus of his invention.
Invention of an Automatic " Barrage."
Description of a Pump without Piston or Valves, applied in several localities.
Description of a New Apparatus; also a Valvular Piston for working a Pump by means of a Variable Fall of Water. This Motor was used at the Palais de l'Elisée.

1855. The two preceding years were employed in making experiments for which he received a Medal of the First Class at the Paris International Exhibition.
Experiments on a New Hydraulic Machine.
Experiments on a means of Diminishing the Resistance of Water in Curves by Concentric Curved Blades.

1856. Experiments on the Regulators of Hydraulic Machines, on Liquid Surfaces, and on the Theories of several pieces of Apparatus.

1857. New Machines for Drainage in Special Cases. New Means of Drainage by the Suction of Sea Waves without any moving Piece.

1858. Observations on the Motion of Water in Respect to the Geological Formation of the Valleys through which it flows.

1859. Properties of the Single-valved Hydraulic Ram transformed into a Blowing Engine.

M. de Cuyper, Professor of Mechanics at the University of Liége, published a memoir the same year to defend the rights of M. de Caligny with reference to Blowing Engines or Air Compressors, one form of which had been employed for driving the Mt. Cenis Tunnel.

1860. New Methods of Compressing Air by means of a Waterfall.

1861. Observations on the Effects of Heat in the Reversed Siphons of the Compressors at Mt. Cenis.

1862. Description of a New Vertical Water-wheel with Plunging Tubes and Liquid Oscillating Floats.
On the Vibration of Liquid Columns.
On the Waves of the Sea at Fécamp.

1863. Experiments on the Phenomena of Suction; on Waves, etc.
On an Improvement in Turbines.

1864. Studies on Earthquakes.
It was on the occasion of the employment of his compressors that he was nominated Chevalier of the Order of St. Maurice and Lazare in 1864, and Chevalier of the Order of St. Gregory the Great in 1865.

1866. Considerations on the Nature of Liquid Friction under Great Pressure.

1867. Application of a New System of Canal Locks to Chains of Locks.
Transformation of Rotative Pumps into Hydraulic Motors.
New Machines for Drainage at any Depth.

1868. Result of the Experiments made by the International Jury of the Paris Universal Exhibition of 1867 upon Caligny's Apparatus without Valves with an Oscillating Tube; for which a silver medal was awarded.

After the presentation of several notes, M. de Caligny was elected Correspondent of the Institute of France.

He was already Corresponding Member of the Royal Academy of Sciences at Lisbon; the Institute of Coimbra, Portugal; the Society of Engineers and Architects, Portugal; the Academy of Sciences at Philadelphia; the Pontifical Academy of Lincei at Rome; the Geographical Academy at Florence; the Royal Society at Prague; the Scientific Societies at Königsberg, Embden, Dantzic, Luxembourg, Zealand, and the Academies of Sciences at Rouen, Caen, Bordeaux, Cherbourg, Evreux, Avranches; also Member of the Imperial Society of Naturalists of Moscow, and Honorary Member of the Society of Physics at Geneva.

1869. On the occasion of the application of his system of locks, he was nominated Chevalier of the Order of Leopold of Belgium.

1872. Notes upon the Liquid Veins formed by the Blow of the Hydraulic Ram.

On Waves against Convergent Dikes and Inclined Beaches.

Presented to the French Academy of Sciences.

1873. Note on the Flow of Water over the Ostien Marsh.

Application of this was made by M. Moro, who recognized Caligny's priority.

Experiments on the Motion of Waves dashing up Inclined Planes.

Experiments upon the Effects of the lateral Communication of Motion by a running Stream traversing a Reservoir.

1874–75. Experiments made in company with M. Bertin, then Marine Engineer in the Arsenal at the Port of Cherbourg, upon an experimental Canal put at their Disposition by the Minister of Marine.

1876. Experiments at Aubois Lock, and New Studies on Canal Locks.

1877. Experiments on several Kinds of Waves, and on Back-water.

1878. Experiments made with M. Bertin on the Action of Waves on Sailing Vessels; on their Action on Beaches, and on Artificial Rock-work.

The Jury for the Paris Exhibition of 1878 awarded him a Silver Medal.

1878–79. New Studies on the Hydraulic Ram.

These principles were applied by M. Chemin in different ways in laying the foundations of locks.

The Foundation of the Ancient Port of Cherbourg, 1686–1739 to 1743–1758. Published in Collaboration with M. Bertin.

1880–82. Theoretical and Experimental Researches on the Oscillations of Water and Hydraulic Machines with Oscillating Liquid Columns. In two octavo volumes.

1881–82. Experiments at the Cherbourg Arsenal with Bent Tubes; at the Aubois Lock, upon the Automatic Movement of the System; and at Flottemanville on a Lifting Machine which was employed for Irrigations at great heights.

1883. Realization of the Automatic Working of the System applied at the Aubois Lock with neither Saving-basin, Valve, nor Cataract.

1884. For his great work, he received a Gold Medal from the Universal Exhibition at Amsterdam, and a Diploma of Honor from that at New Orleans.

Elected Corresponding Member of the Royal Academy of Sciences at Madrid.

New Experiments at the Aubois Lock.

1885. Gold Medal from the Universal Exhibition at Antwerp.

Experiments on a New Machine for compressing Air by Means of a Waterfall.

1887. An improved form of his machine for raising water was erected at Flottemanville. This machine is rustic in its character, and well adapted to the use of country laborers.

1888. A new Hydraulic Machine of a much greater efficiency than his other apparatus.

Elected Honorary Member of the Institution of the Royal Netherland Engineers, and of the Royal Belgian Academy of Sciences.

The Diploma of Honor was given him by the Universal Exhibition of Brussels; a Gold Medal from that of Barcelona, and a Diploma of Honor from that at Melbourne. Other Medals and Diplomas were given which need not be mentioned in detail.

1888–92. Notes on Improvements applicable to his Inventions.

1894. WILLIAM WATSON.

BENJAMIN JOWETT.

BENJAMIN JOWETT, Master of Balliol College and Regius Professor of Greek in the University of Oxford, died on October 1, 1893. He was born at Camberwell in 1817, and attended St. Paul's School in London. He was a student of Balliol, and received his Bachelor's degree at Oxford in 1839, with a first class in *Literæ Humaniores*. He became Tutor of Balliol in 1842, and Master of Balliol in 1870. He held the office of Vice-Chancellor of the University from 1882 to 1886. He was made Regius Professor of Greek in 1855, and he held this office until his death. He received the honorary degree of Doctor in Theology from the University of Leyden in 1875, and that